Figure 1

Figure 2

Figure 2A

More Mirrored
Web Servers

Web
Server
(Master)   *110*

More Client Machines

Contestant
Database   *130*

Web
Server
(Mirror)   *110*

Web Browser   *320*

Client
Machine n   *160*

Figure 2B

Web Browser   *320*

Client
Machine 2 . . .   *160*

Web Browser   *320*

Client
Machine 1   *160*

Contestant Database 130

Login Server 120

Contest Client 340
Client Machine 1 160

Contest Client 340
Client Machine 2 160

Contest Client 340
Client Machine 3 160

Contest Client 340
Client Machine 4 . . . 160

Contest Client 340
Client Machine r 160

Figure 2C

Client Machine 160

Web Browser	Contest Plug-In	Contest Client

Operating System 240

Standard Device Drivers 280 | Contest Hooks and Drivers 350

Clock and Timer Hardware	Output Hardware (Video Display, Speakers, Etc.)	Input Hardware (Keyboard, Mouse, Microphone, Etc.)	Network Interface (Modem, Ethernet, Etc.)

GPS

Figure 2D

Figure 2D1

Global Synchronization Unit 175

GPS Antenna 730

GPS Receiver → GPS Disciplined Clock

700

710

Encryption and Decryption Module

Central Processor

Non-Volatile Memory

740

750

760

Host Computer Interface (ISA, PCI, RS323, USB, PCMCIA, etc)

720

Figure 2D2

Client Machine 160

320

Web Browser | Contest Plug-In

330

340

Contest Client

Operating System

240

Standard Device Drivers 280 | Contest Hooks and Drivers

350

Clock and Timer Hardware

290

GSU

175

Output Hardware (Video Display, Speakers, Etc.)

310

Input Hardware (Keyboard, Mouse, Microphone, Etc.)

300

Network Interface (Modem, Ethernet, Etc.)

215

Figure 2D3

Output
(Video, Audio, etc)

Enhanced GSU

177

Input (Keyboard,
Mouse, Microphone, etc)

Client Machine 160

Internet

Server

GPS Clock

170

Figure 2D4

Enhanced Global Synchronization Unit 177

GPS Antenna 730

GPS Receiver

GPS Disciplined Clock

700

710

750

Encryption and Decryption Module

740

Central Processor

Non-Volatile Memory

760

Input Device Monitor and Pass-through

770

Host Computer Interface (ISA, PCI, RS323, USB, PCMCIA, etc)

720

Output pass-through and signal generation module

780

Figure 2D5

Game Server 150 270

Game Server Daemon

Operating System 240

Standard and Customized Device Drivers 230

| GPS 170 | High Precision Clock or Timer Hardware 200 | Standard I/O Hardware 220 | High Performance Network Interface 210 |

Figure 2E

Web Server 110

Web Server Software (Supports HTML, Java, CGI, Etc.)	360
Operating System	240
Standard Device Drivers	280
High Performance Network Interface	210
Standard I/O Hardware	220

Figure 2F

Primary Server 100

Primary Server Daemon	Contest Management Interface	250 / 260

Operating System 240

Standard and Customized Device Drivers 230

High Precision Clock or Timer Hardware	Standard I/O Hardware	High Performance Network Interface

GPS 170

200 220 210

Figure 2G

Login Server 120

370

Login Server Daemon

Operating System 240

Device Drivers 230

High Performance Network Interface 210

Standard I/O Hardware 220

Figure 2H

Contest Web Site
(HTML)
400

110

405
Registration Information

Web Server

Contestant Username
410   and Password

Contest Software
415   Download

Client Machine

160

Figure 3A

100 ~ | Primary Server | → Game Server List 420 → | Login Server | ~ 120

Figure 3B

Game Server 150

Login Server 120

Status Request 425

Game Server Status
Game Server Public Key 430

Contestant Login Request 445

Game Server Access Code 450

Figure 3C

120 —

Login Server

Contestant Login Request   435
Client Machine Public Key

440   Contestant ID

455   Game Server Address
Game Server Access Code

Client Machine

— 160

Figure 3D

Game Server 150

Client Machine 160

Contestant ID 460	
Game Server Access Code	
Client Machine Public Key	

463 Game Server Public Key

480 Encrypted Query and Start-Time

485 Query Decryption Key

Response Notification Hash 490

495 Response Data Request

Response Data and 500
Security Verification Hash

515 Security Log Request

Security Log 520

535 Contest Results

Figure 3E

Primary Server 100

Game Server 150

Game Server Public Key 465

Primary Server Public Key 470

Encrypted Query
Encrypted Start-Time
Encrypted Answer 475

Preliminary Results 505

Security Analysis Request 510

Security Analysis Results 525

Contest Results 530

Figure 3F

Figure 3G

Start

A | User Registers and Downloads Contest Software to enable globally-synchronized and secure networked client machine

B | Contestant logs on to game server

C | Encrypted query and start time downloaded to client machine

D | Game server synchronizes the clock and display update cycle of the client machine

E | At the start-time, as determined by the synchronized local clock, the query is presented to the contestant

F | Contestant Submits Timestamped Response

G | Responses Judged and winner(s) determined

Done

Figure 4

User Registers and Downloads Contest Software

Start

A | User Browses Contest Web Site

B | User submits registration information to web server

C | Web server creates contestant record in contestant database for new contestant

D | Contestant ID stored in contestant record

E | Web server assigns initial username and password to contestant

F | Contestant username and password sent to contestant via e-mail

G | Contestant logs on to secure "members only" area of web site

H | Contestant downloads contest software

I | Contestant installs contest software to create globally-synchronized secure contest client machine

Done

Figure 4A

Contestant logs on to game server

Start

A | Primary server transmits game server list to login server

B | Login server sends status request to game server

C | Game Servers transmit status and loading information to Login server

D | Contestant enters username and password in contest client to login to game

E | Contest client transmits username and password to login server

F | Login server verifies contestant username and password

G | Login server transmits contestant identifier (ID) to contest client

H | Login server selects game server to assign to this contestants client machine

I | Login server transmits login request, including contestant ID to selected game server

J | Game server transmits game server access code to login server

K | Login server transmits game server address and game server access code to client machine

L | Client machine sends contestant ID and game server access code to game server to establish connection with game server

Done

Figure 4B

Encrypted query and start-time downloaded to client machine

$$\text{Start}$$

A — Contest perators enter queries and answers into query/answer database

B — Game server transmits game server public key to primary server

C — Primary server transmits primary server public key to game server

D — Contest operator or primary server software selects query and start-time

E — primary server generates query encryption and decryption keys

F — primary server encrypts query using query encryption key

G — primary server creates message m_1 containing encrypted query, query decryption key, and start-time

H — primary server encrypts message m_1 using game server's public key

I — Encrypted message m_1 sent to game server

J — game server decrypts message m_1 and creates message m_2 containing encrypted query and start-time

K — Game server encrypts m_2 using game client's public key

L — Encrypted m_2 sent to client machine

M — Client machine decrypts m_2 and stores encrypted query and start-time

$$\text{Done}$$

Figure 4C

Client machine clock characterized and display update cycle synchronized with global clock

(Client Machine With Basic GSU)

Start

A | Client machine calculates expected error E_d between GSU-provided local start-time t_d and closest display update cycle t_a

B | Client machine adjusts display update cycle over a number of cycles to minimize E_d

Done

Figure 4D1

Client machine clock characterized and display update cycle synchronized with global clock

(Client Machine With Enhanced GSU)

Start

A │ No actions required (all functions performed automatically by GSU)

Done
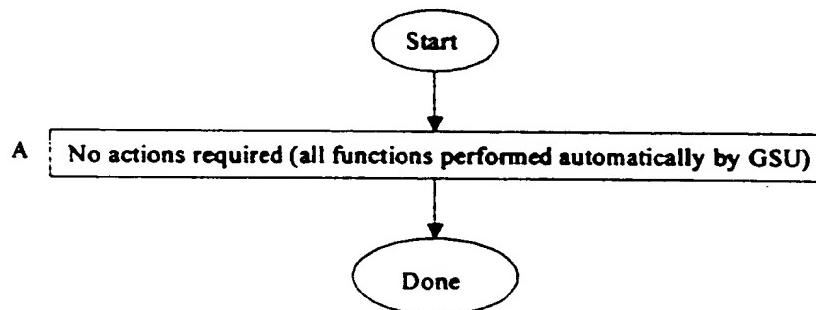
Figure 4D2

Client machine clock characterized and display update cycle synchronized with global clock

(Client Machine Without GSU)

```
        ( Start )
           │
           ▼
┌──────────────────────────────────────────────────────────────┐
│   Client machine uses statistical sampling and curve-fitting to determine │
│ A functional relationship between local clock t₁ and a global clock t_g  │
└──────────────────────────────────────────────────────────────┘
           │
           ▼
┌──────────────────────────────────────────────────────────────────────┐
│ B  Client machine calculates local clock start-time t_sl corresponding to desired global clock start-time t_sg │
└──────────────────────────────────────────────────────────────────────┘
           │
           ▼
┌──────────────────────────────────────────────────────────────────────┐
│ C  Client machine calculates expected error E_d between local start-time t_sl and closest display update cycle t_d │
└──────────────────────────────────────────────────────────────────────┘
           │
           ▼
┌──────────────────────────────────────────────────────────────────────┐
│ D  Client machine adjusts display update cycle over a number of cycles to minimize E_d │
└──────────────────────────────────────────────────────────────────────┘
           │
           ▼
        ( Done )
```

Figure 4D3

At start-time, the query is presented to the contestant

(Client Machine With Basic GSU)

```
            ( Start )
                |
                v
A  | Client machine loads query into GSU |
                |
                v
B  | GSU decrypts query prior to start-time and sends to client machine |
                |
                v
C  | Client machine renders data to offscreen memory area |
                |
                v
D  | During the display update cycle preceding the cycle that completes at the start time,
       the offscreen area is "flipped" to be the visible area |
                |
                v
E  | The client machine display draws the query on the screen, completing the drawing at the start-time |
                |
                v
            ( Done )
```

Figure 4E1

At start-time, the query is presented to the contestant

(Client Machine With Enhanced GSU)

```
            ( Start )
                |
                v
   A | Client machine loads encrypted query into GSU |
                |
                v
   B | GSU automatically decrypts query immediately prior to start-time |
                |
                v
   C | GSU overrides display and presents query precisely at start-time |
                |
                v
            ( Done )
```

Figure 4E2

At start-time, the query is presented to the contestant

(Client Machine Without GSU)

```
                    ┌───────┐
                    │ Start │
                    └───────┘
                        │
                        ▼
A    ┌──────────────────────────────────────────────────────┐
     │ Game server transmits query decryption key to client machine │
     └──────────────────────────────────────────────────────┘
                        │
                        ▼
     B   ┌──────────────────────────┐
         │ Client machine decrypts query │
         └──────────────────────────┘
                        │
                        ▼
     C   ┌────────────────────────────────────────────┐
         │ Client machine renders data to offscreen memory area │
         └────────────────────────────────────────────┘
                        │
                        ▼
D    ┌──────────────────────────────────────────────────────────────────┐
     │ During the display update cycle preceding the cycle that completes at the start time, │
     │        the offscreen area is "flipped" to be the visible area       │
     └──────────────────────────────────────────────────────────────────┘
                        │
                        ▼
E    ┌────────────────────────────────────────────────────────────────────────────┐
     │ The client machine display draws the query on the screen, completing the drawing at the start-time │
     └────────────────────────────────────────────────────────────────────────────┘
                        │
                        ▼
                    ┌───────┐
                    │ Done  │
                    └───────┘
```

Figure 4E3

Contestant submits timestamped response

(Client Machine With Basic GSU)

Start

A | Contestant enters the response into the client machine

B | Client machine sends response to GSU for timestamping and digital signature generation

C | Client machine transmits GSU timestamp to game server

D | Server requests full response from client machine

E | Client machine encrypts response, response timestamp, and generates hash-value of security verification logs

F | Client machine transmits the encrypted response, timestamp, and security verification log hash-value to game server

Done

Figure 4F1

Contestant submits timestamped response

(Client Machine With Enhanced GSU)

(Start)

A | Contestant enters the response through the GSU into the client machine

B | GSU automatically generates timestamp for the response

C | Client machine transmits GSU timestamp to game server

D | Server requests full response from client machine

E | Client machine encrypts response, response timestamp, and generates hash-value of security verification logs

F | Client machine transmits the encrypted response, timestamp, and security verification log hash-value to game server

(Done)

Figure 4F2

Contestant submits timestamped response

(Client Machine Without GSU)

Start

A | Contestant enters the response into the client machine

B | Client machine associates a timestamp with the response, corresponding to the time of the response submission on the synchronized local clock

C | Client machine transmits hash value of response and response time

D | Server requests full response from client machine

E | Client machine encrypts response, response timestamp, and generates hash-value of security verification logs

F | Client machine transmits the encrypted response, timestamp, and security verification log hash-value to game server

Done

Figure 4F3

Responses Judged and Winners Determined

(Start)

↓

A | Game server judges and ranks entries from all its clients

↓

B | Preliminary rankings encrypted using primary servers public key

↓

C | Encrypted preliminary rankings sent to primary server

↓

D | Primary server decrypts rankings from all game servers

↓

E | Primary server calculates overall ranking of contestants and identifies winner(s)

↓

F | Primary server transmits security verification request to game servers for winning entries

↓

G | Game server sends verification log request to client machine

↓

H | Client machine transmits verification log to game server

↓

I | Game server validates verification log using previously transmitted security verification log hash value

↓

J | Game server performs analysis of security verification log contents to detect fraudulent or suspicous entries

↓

K | Game server transmits results of analysis to primary server

↓

L | Primary server accepts, rejects, or flags the entry for followup by other (manual) means

↓

M | Primary server revises list of contest results based on security verification results

↓

N | Primary server transmits final contest results to game server

↓

O | Game server transmits contest results to client machines

↓

P | Primary server transmits final contest results to web server for posting

↓

(Done)

Figure 4G

180
GPS

100
Primary
Server

170
GPS

35
Trader
Database

45
Real-Time
Market State
Server

190
Network

120
Login
Server

Web
Server

110

55
Real-Time
Price-Quotation
and Trading Server

170
GPS

160
Client
Machine

175
GSU

Figure 5

Figure 5A

Figure 5B

F I G. 6

FIG. 6A

F I G. 6B

F I G. 6C

Client Machine 160

Web Browser

AUCTION Plug-In 330

320

AUCTION Client 340

Operating System 240

Standard Device Drivers 280

AUCTION Hooks and Drivers 350

GPS 170

Clock and Timer Hardware 290

Output Hardware (Video Display, Speakers, Etc.) 310

Input Hardware (Keyboard, Mouse, Microphone, Etc.) 300

Network Interface (Modem, Ethernet, Etc.) 215
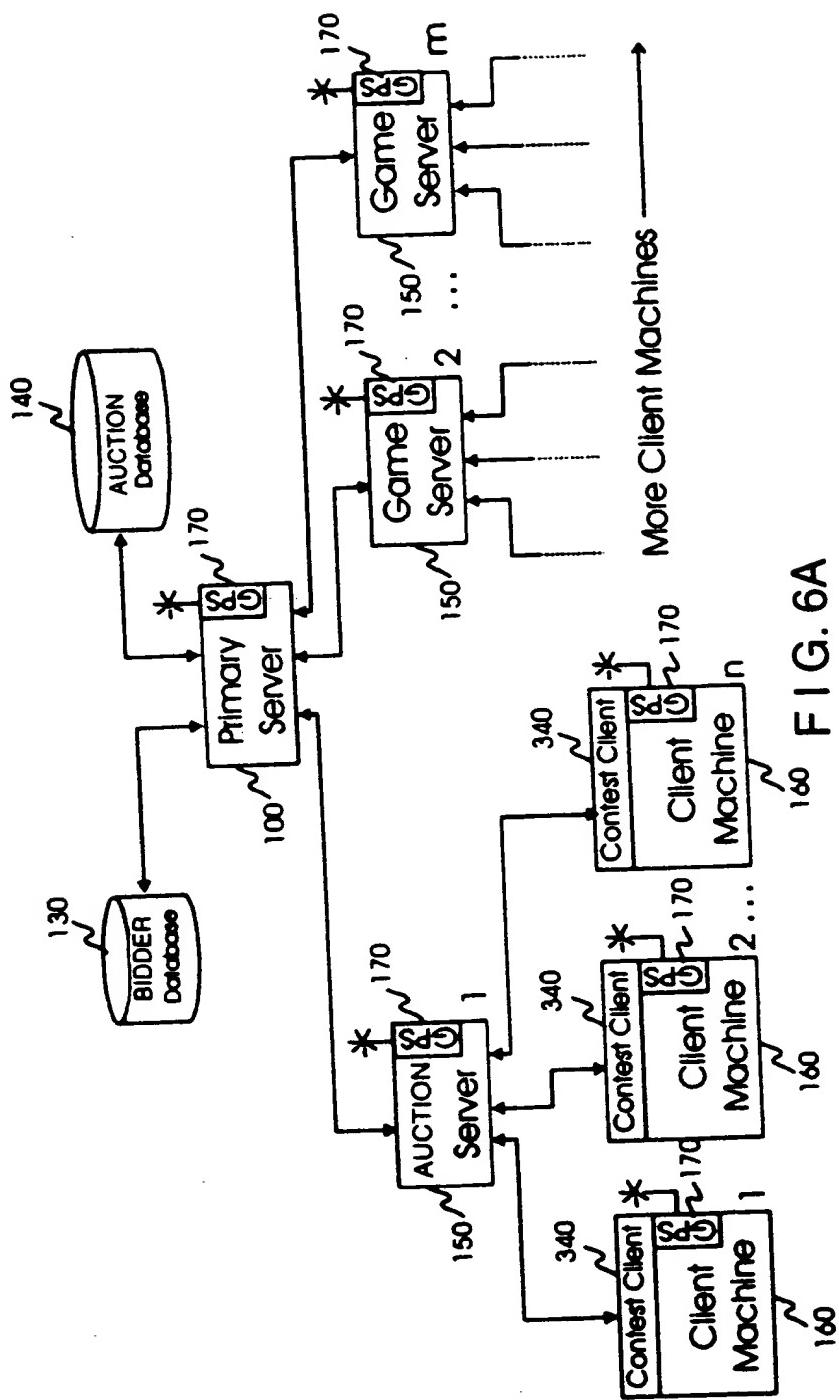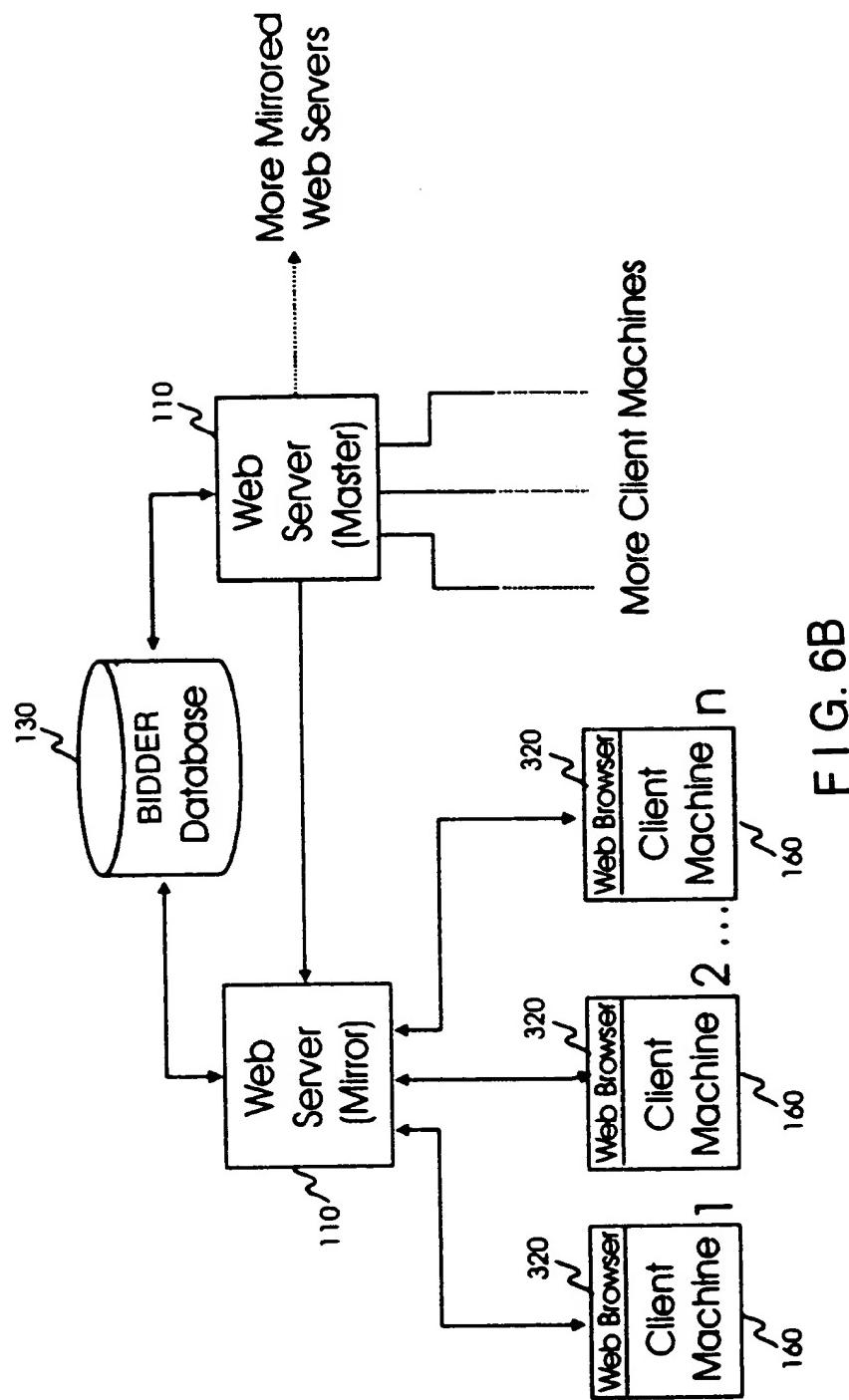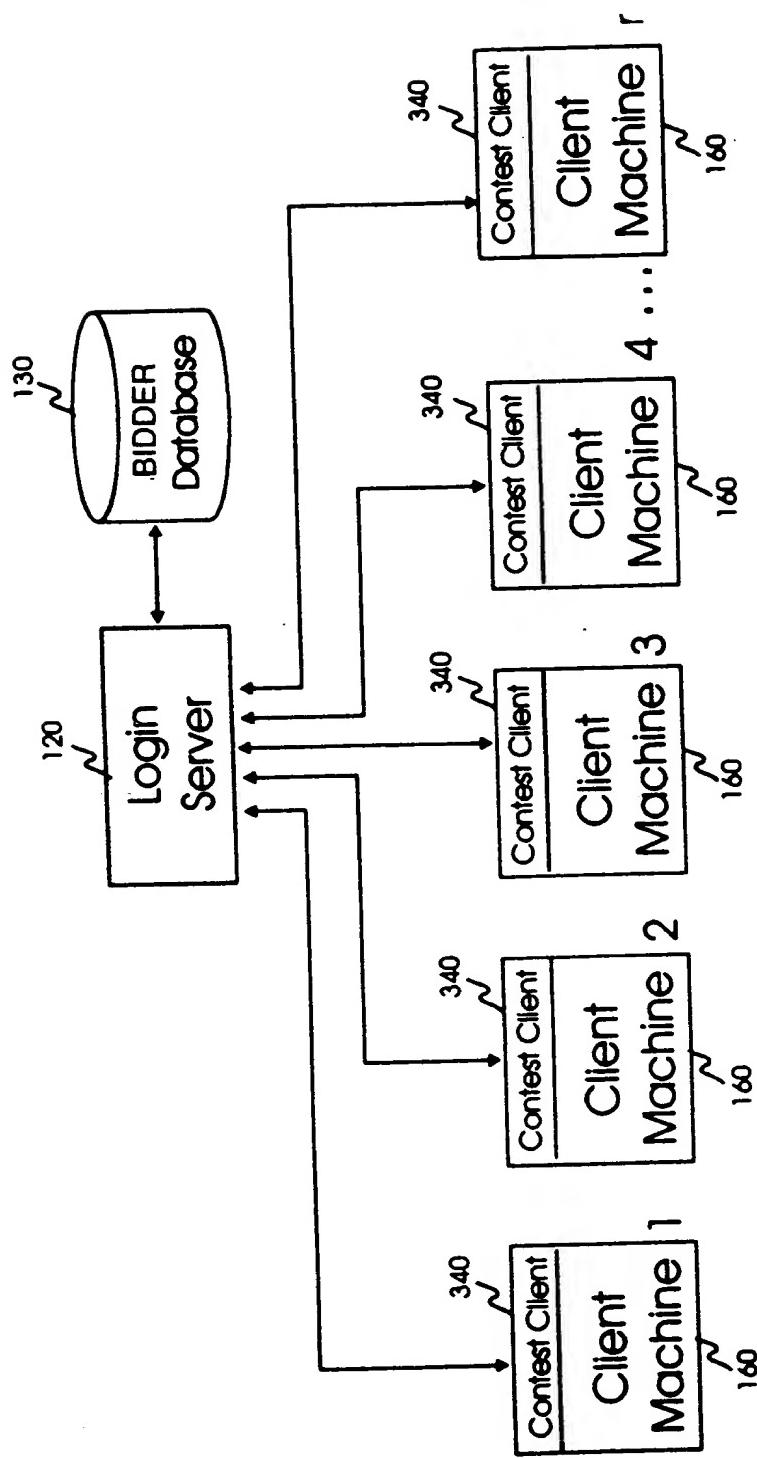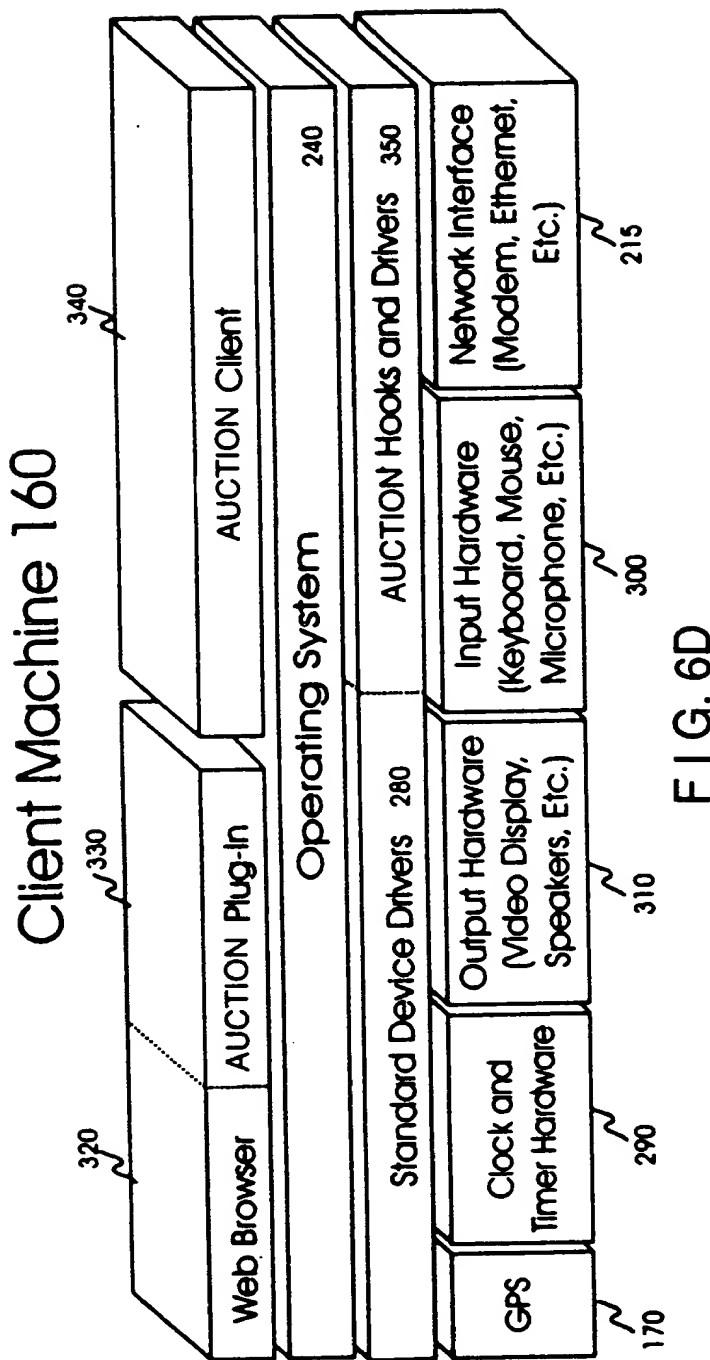
FIG. 6D

AUCTION SERVER 150'

270

AUCTION SERVER DAEMON

Operating System 240

Standard and Customized Device Drivers 230

High Performance
Network Interface 210

Standard I/O Hardware 220

High Precision
Clock or Timer
Hardware 200

GPS 170

F I G. 6E

Web Server 110

Web Server Software   (Supports HTML, Java, CGI, Etc.)

Operating System

240

Standard Device Drivers

260

High Performance
Network Interface

210

Standard I/O Hardware

220

360

FIG. 6F

Primary Server 100'

260'

Primary Server Daemon | AUCTION MANAGEMENT INTERFACE

250'

Operating System

240

Standard and Customized Device Drivers

230

GPS | High Precision Clock or Timer Hardware | Standard I/O Hardware | High Performance Network Interface

170 | 200 | 220 | 210

F I G. 6G

Login Server 120   370

Login Server Daemon

Operating System   240

Device Drivers   230

Standard I/O Hardware   220

High Performance
Network Interface   210

F I G. 6H

FIG. 7A

Primary Server

100

Auction Server List
420

Login Server

120

FIG. 7B

FIG. 7C

120

160

Login Server

Client Machine

Bidder Login Request 435
Client Machine Public Key

440 Bidder ID

455 Auction Server Address
Auction Server Access Code

F I G. 7D

FIG. 7E

FIG. 7F

Primary Server

Auction Announcements
(ftp)
433

Web Server

100

110

Auction Results and
Auction Standings
(ftp)
540

FIG. 7G

LOGIN INFORMATION DATA FIELDS

USERNAME
PASSWORD
NAME
ADDRESS
EMAIL
CREDIT CARDS
CREDIT INFORMATION/RATING
UNIQUE IDENTIFICATION
NETWORK LATENCY HISTORY

FIG. 8A

BID HISTORY
AUCTION INFORMATION DATA FIELDS

ITEM NUMBER
DESCRIPTION
CATEGORY
MINIMUM SALE AMOUNT
BID INCREMENTS
START TIME
END TIME (IF APPLICABLE)
HIGHEST BID
ALL BID INFORMATION
OWNER
ADDRESS
EMAIL
PHONE
SALE HISTORY
BUYER COMMENTS

FIG. 8B

BID INFORMATION DATA FIELDS

USERNAME
UNIQUE IDENTIFICATION
SUBMISSION-TIME TIME STAMP
RECEIPT-TIME TIME STAMP
BID AMOUNT
VERIFICATION KEY

FIG. 8C

THE AUCTION PROCESS

START

A — USER REGISTERS AND DOWNLOADS AUCTION SOFTWARE TO ENABLE GLOBALLY-SYNCHRONIZED AND SECURE NETWORKED CLIENT MACHINE

B — BIDDER LOGS ON TO AUCTION SERVER

C — ENCRYPTED AUCTION INFORMATION AND START-TIME DOWNLOADED TO CLIENT MACHINE

D — AUCTION SERVER SYNCHRONIZES THE CLOCK AND DISPLAY UPDATE CYCLE OF THE CLIENT MACHINE

E — AT THE START-TIME, AS DETERMINED BY THE SYNCHRONIZED LOCAL CLOCK, THE AUCTION IS OPENED AND THE BIDDING INFORMATION DISPLAYED

F — BIDDER SUBMITS TIME-STAMPED BID

G — BIDS RECEIVED, VERIFICATION SENT TO CLIENT MACHINE, AND BID INFORMATION UPDATED

H — NO ADDITIONAL BIDS RECEIVED, LAST CALL FOR BIDS, AND THE AUCTION CLOSES

DONE

F I G. 9

USER REGISTERS AND DOWNLOADS AUCTION SOFTWARE

```
                    ( START )
                        │
                        ▼
A ──  USER BROWSES AUCTION WEB SITE
                        │
                        ▼
B ──  USER SUBMITS REGISTRATION INFORMATION
      TO WEB SERVER
                        │
                        ▼
C ──  WEB SERVER CREATES AUCTION RECORD IN AUCTION
      DATABASE FOR NEW BIDDER
                        │
                        ▼
D ──  BIDDER ID STORED IN AUCTION RECORD
                        │
                        ▼
E ──  WEB SERVER ASSIGNS INITIAL USERNAME
      AND PASSWORD TO BIDDER
                        │
                        ▼
F ──  BIDDER USERNAME AND PASSWORD
      SENT TO BIDDER VIA E-MAIL
                        │
                        ▼
G ──  BIDDER LOGS ON TO SECURE
      "MEMBERS ONLY" AREA OF WEB SITE
                        │
                        ▼
H ──  BIDDER DOWNLOADS AUCTION SOFTWARE
                        │
                        ▼
I ──  BIDDER INSTALLS AUCTION SOFTWARE
      TO CREATE GLOBALLY-SYNCHRONIZED
      SECURE AUCTION CLIENT MACHINE
                        │
                        ▼
                    ( DONE )
```

F I G. 9A

BIDDER LOGS ON TO AUCTION SERVER

START

A — PRIMARY SERVER TRANSMITS
GAME SERVER LIST TO LOGIN SERVER

B — LOGIN SERVER SENDS
STATUS REQUEST TO AUCTION SERVER

C — AUCTION SERVER TRANSMITS STATUS AND
LOADING INFORMATION TO LOGIN SERVER

D — BIDDER ENTERS USERNAME AND PASSWORD IN
AUCTION CLIENT TO LOGIN TO AUCTION

E — AUCTION CLIENT TRANSMITS USERNAME AND
PASSWORD TO LOGIN SERVER

F — LOGIN SERVER VERIFIES CONTESTANT
USERNAME AND PASSWORD

G — LOGIN SERVER TRANSMITS BIDDER INDENTIFIER (ID)
TO AUCTION CLIENT

H — LOGIN SELECTS AUCTION SERVER TO ASSIGN
TO THIS BIDDER'S CLIENT MACHINE

A

F I G. 9B1

```
                              ( A )
                                │
                                ▼
        ┌─────────────────────────────────────────────┐
   I    │     LOGIN SERVER TRANSMITS LOGIN REQUEST,    │
        │ INCLUDING BIDDER ID TO SELECTED AUCTION SERVER │
        └─────────────────────────────────────────────┘
                                │
                                ▼
        ┌─────────────────────────────────────────────┐
   J    │    AUCTION SERVER TRANSMITS AUCTION SERVER    │
        │        ACCESS CODE TO LOGIN SERVER           │
        └─────────────────────────────────────────────┘
                                │
                                ▼
        ┌─────────────────────────────────────────────┐
        │          LOGIN SERVER TRANSMITS              │
   K    │       AUCTION SERVER ADDRESS AND             │
        │ AUCTION SERVER ACCESS CODE TO CLIENT MACHINE │
        └─────────────────────────────────────────────┘
                                │
                                ▼
        ┌─────────────────────────────────────────────┐
        │  CLIENT MACHINE SENDS BIDDER ID AND AUCTION  │
   L    │  SERVER ACCESS CODE TO AUCTION SERVER TO     │
        │ ESTABLISH CONNECTION WITH AUCTION SERVER     │
        └─────────────────────────────────────────────┘
                                │
                                ▼
                      (     DONE     )
```

F I G. 9B2

**ENCRYPTED AUCTION INFORMATION AND START-TIME
DOWNLOADED TO CLIENT MACHINE**

START

A — SELLER ENTERS AUCTION INFORMATION
INTO AUCTION DATABASE

B — AUCTION SERVER TRANSMITS AUCTION SERVER
PUBLIC KEY TO PRIMARY SERVER

C — PRIMARY SERVER TRANSMITS PRIMARY SERVER
PUBLIC KEY TO AUCTION SERVER

D — AUCTION OPERATOR OR PRIMARY SERVER SOFTWARE
SELECTS AUCTION START-TIME

E — PRIMARY SERVER GENERATES AUCTION INFORMATION
ENCRYPTION AND DECRYPTION KEYS

F — PRIMARY SERVER ENCRYPTS AUCTION INFORMATION
USING AUCTION ENCRYPTION KEY

G — PRIMARY SERVER CREATES MESSAGE m1 CONTAINING
ENCRYPTED AUCTION INFORMATION, AUCTION
DECRYPTION KEY, AND START TIME

H — PRIMARY SERVER ENCRYPTS MESSAGE m1 USING THE
AUCTION SERVER'S PUBLIC KEY

A

F I G. 9C1

```
        ( A )
          │
          ▼
┌─────────────────────────────────────┐
I ─┤ ENCRYPTED MESSAGE m1 SENT TO AUCTION SERVER │
└─────────────────────────────────────┘
          │
          ▼
┌─────────────────────────────────────┐
J ─┤ AUCTION SERVER DECRYPTS MESSAGE m1 AND │
   │ CREATES MESSAGE m2 CONTAINING ENCRYPTED │
   │ AUCTION INFORMATION AND START-TIME │
└─────────────────────────────────────┘
          │
          ▼
┌─────────────────────────────────────┐
K ─┤ AUCTION SERVER ENVRYPTS m2 USING AUCTION │
   │ CLIENT'S PUBLIC KEY │
└─────────────────────────────────────┘
          │
          ▼
┌─────────────────────────────────────┐
L ─┤ ENCRYPTED m2 SENT TO CLIENT MACHINE │
└─────────────────────────────────────┘
          │
          ▼
┌─────────────────────────────────────┐
M ─┤ CLIENT MACHINE DECRYPTS m2 AND STORES │
   │ ENCRYPTED QUERY AND START-TIME │
└─────────────────────────────────────┘
          │
          ▼
     ( DONE )
```

F I G. 9C2

AUCTION SERVER SYNCHRONIZES THE CLOCK AND DISPLAY UPDATE CYCLE OF THE CLIENT MACHINE

START

A — CLIENT MACHINE USES STATISTICAL SAMPLING AND CURVE-FITTING TO DETERMINE FUNCTIONAL RELATIONSHIP BETWEEN LOCAL CLOCK t_1 AND A GLOBAL CLOCK t_g

B — CLIENT MACHINE CALCULATES LOCAL CLOCK START-TIME

C — CLIENT MACHINE CALCULATES EXPECTED ERROR Ed BETWEEN LOCAL START-TIME t_{s1} AND CLOSEST DISPLAY UPDATE CYCLE t_{d1}

D — CLIENT MACHINE ADJUSTS DISPLAY UPDATE CYCLE OVER A NUMBER OF CYCLES TO MINIMIZE E_d

DONE

F I G. 9D

HIGH LEVEL BIDDING PROCESS

$$START$$

A — AUCTION SERVER OPENS BIDDING
FOR ITEMS A AT t_1 TIME

B — AUCTION SERVER IS ABLE TO ACCEPT BIDS FOR ITEM X
THAT ARE TIME STAMPED AFTER t_1

C — CLIENT MACHINE SENDS BID TO SERVER AT t_2
AND TIME STAMPS IT (GPS CLOCK)

D — AUCTION SERVER RECEIVES BID AT t_3
AND TIME STAMPS IT (GPS CLOCK)

E — SERVER SENDS CONFIRMATION OF BID RECEIPT TO
CLIENT MACHINE CONTAINING TIME STAMPS

F — SERVER UPDATES ALL CLIENT MACHINES WITH
HIGHEST BID INFORMATION FOR ITEM A

G — STEPS 3-4 CONTINUE UNTIL SERVER RECEIVES
NO BIDS FOR x SECONDS

H — SERVER SENDS NOTICE OF FINAL BID TO
ALL CLIENT MACHINES AT t_4

(A)

F I G. 9E1

A

I — SERVER WAITS y SECONDS FOR A NEW BID
FROM ANY CLIENT MACHINE

J — AT t_4 + y SECONDS, THE BIDDING PROCESS IS CLOSED

K — THE SERVER WAITS z SECONDS FOR ANY BIDS TIME
STAMPED PRIOR TO t_4 + y SECONDS

L — IF A NEW HIGHER BID IS RECEIVED THEN
GO TO STEP F (OF FIG. 9E1)

M — ELSE THE ITEM IS SOLD AND THE SERVER UPDATES ALL
CLIENT MACHINES WITH THE FINAL SALE PRICE

DONE

F I G. 9E2

F I G. 10

180 GPS

100 Primary Server

170 GPS

660 Contest Database

610 Remote Administration Server

130 Contestant Database

190 Network

140 Query/Answer Database

110 Web Server

120 Login Server

600 Remote Administration Console

150 Game Server

170 GPS

160 Client Machine

175 GSU

F I G. 10A

Remote Administration Console 600

Web Browser	Remote Administration Client
Administration Plug-In	

Operating System   240

Standard Device Drivers   280

Standard I/O Hardware	Network Interface (Modem, Ethernet, Etc.)

215

220

Clock and Timer Hardware   290

320   640   650

FIG. 10B

Remote Administration Server 610

Remote Administration Daemon

Remote Administration Web Server

620

Operating System

240

Device Drivers

230

Standard I/O Hardware

220

High Performance
Network Interface

210

630

F I G. 10C

F I G. 11

Team 2 Contestants

Team 1 Contestants

Contest-Related Live Video

Queries, Results, and Scores

F I G. 11A

970

980

990

FIG. 12

Set-Top Client Machine 970

971

Firmware Contest Client

Embedded Operating System with Java Virtual Machine   972

Embedded Device Drivers   973

| GSU | Clock and Timer Hardware | Output Hardware (NTSC or Pal Audio/Video) | Input Hardware (Infrared Port) | Modem | TV Tuner and Intercast Decoder |

175   290   974   975   976   977

F I G. 12A

Examples of GSU Inputs for Time and Space Stamping
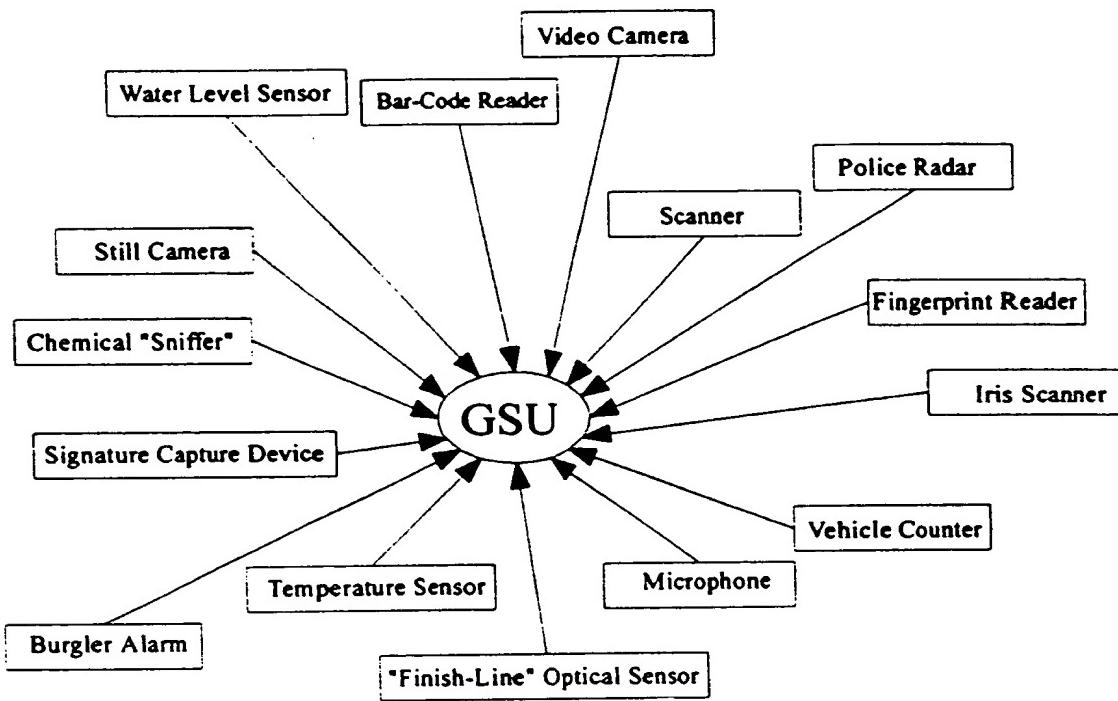
FIG. 13

Embedded GSU Applications
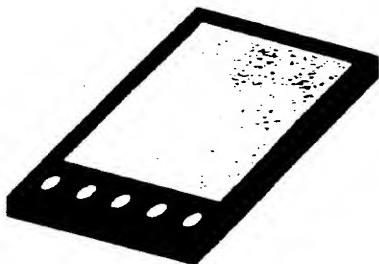
Handheld
Computer

Digital
Camera

75
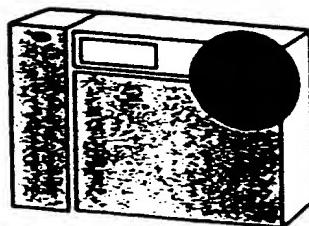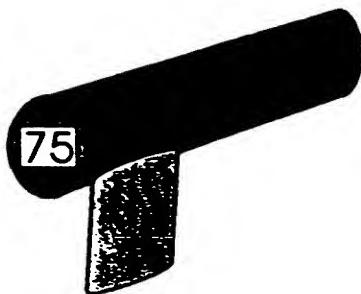
Police
Radar
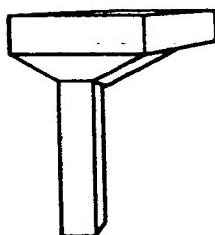
Bar Code
Scanner
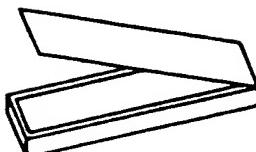
Scanner
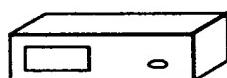
CABLE TV SET-TOP
BOXES
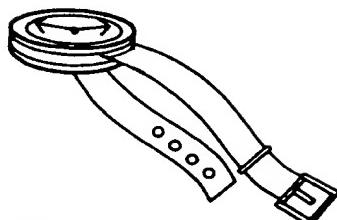
WRIST WATCH

F I G. 14

Peripheral GSU Configurations

PCMCIA

ISA/PCI/SCSI

RS232/USB

F I G. 15

OWNER/OBJECT RDBMS 1001

WEB-BASED OBJECT TRAJECTORY MONITORING SERVER 1002

WEB-BASED OWNER/OBJECT REGISTRATION SERVER 1003

WEB-ENABLED CLIENT MACHINE 1010

190

NETWORK

TIME-SPACE (TS) STAMPING BASED TRACKING SERVER 1000

GPS 170

WEB-ENABLED CLIENT MACHINE 1010

GPS 180

GSU 175

MOBILE GSU-ENABLED CLIENT NETWORK DEVICE 160'

OBJECT TO BE TRACKED

GSU 175

MOBILE GSU-ENABLED CLIENT NETWORK DEVICE 160'

OBJECT TO BE TRACKED

F I G. 16

GSU-ENABLED CLIENT NETWORK DEVICE 160'

340'

TRACKING CLIENT

Operating System 240

TRACKING HOOKS AND DRIVERS 350'

| Standard Device Drivers 280 | | | | Network Interface (Modem, Ethernet, Etc.) |
| GSU | Clock and Timer Hardware 290 | Output Hardware (Video Display, Speakers, Etc.) 310 | Input Hardware 300 | |

175

305 ON-BOARD BATTERY-POWER LEVEL MONITORING MODULE AND SOLAR POWER CELL MODULE

307 PACKAGE-REMOVAL/ TAMPER-EVIDENCE SENSOR

215'

F I G. 16A

ADDRESS LABEL
AND BARCODE

160'

F I G. 16A1

ADDRESS AND
SHIPPING BARCODE
LABEL

160'

SHIPPED PACKAGE

F I G. 16A2

TS-STAMPING BASED TRACKING SERVER 1000

270'

242 — TS-TRACKING SERVER DAEMON

240 — Operating System

230 — Standard and Customized Device Drivers

High Performance
Network Interface

210

GPS
RECEIVER
170

High Precision
Clock or Timer
Hardware
200

Standard I/O Hardware
220

FIG. 16B

WEB-BASED OWNER/OBJECT REGISTRATION SERVER 1003

360

Web Server Software (Supports HTML, Java, CGI, Etc.)

Operating System 240

Standard Device Drivers 280

Standard I/O Hardware 220

High Performance Network Interface 210
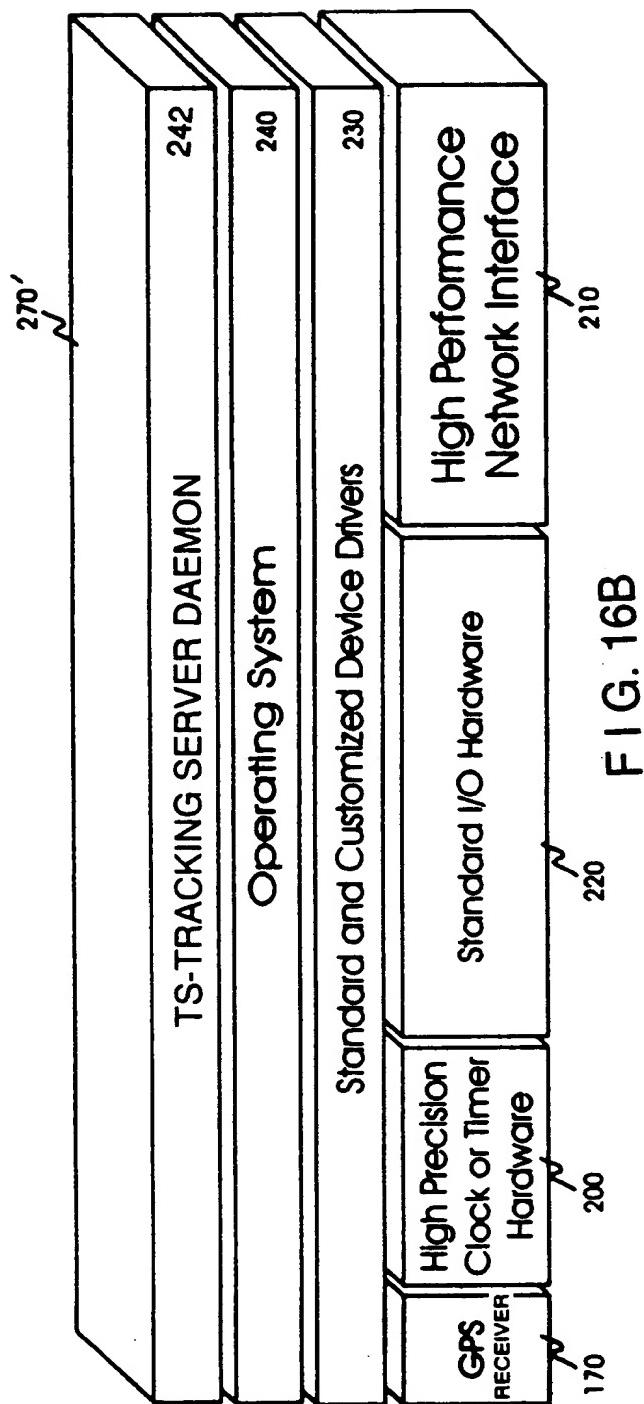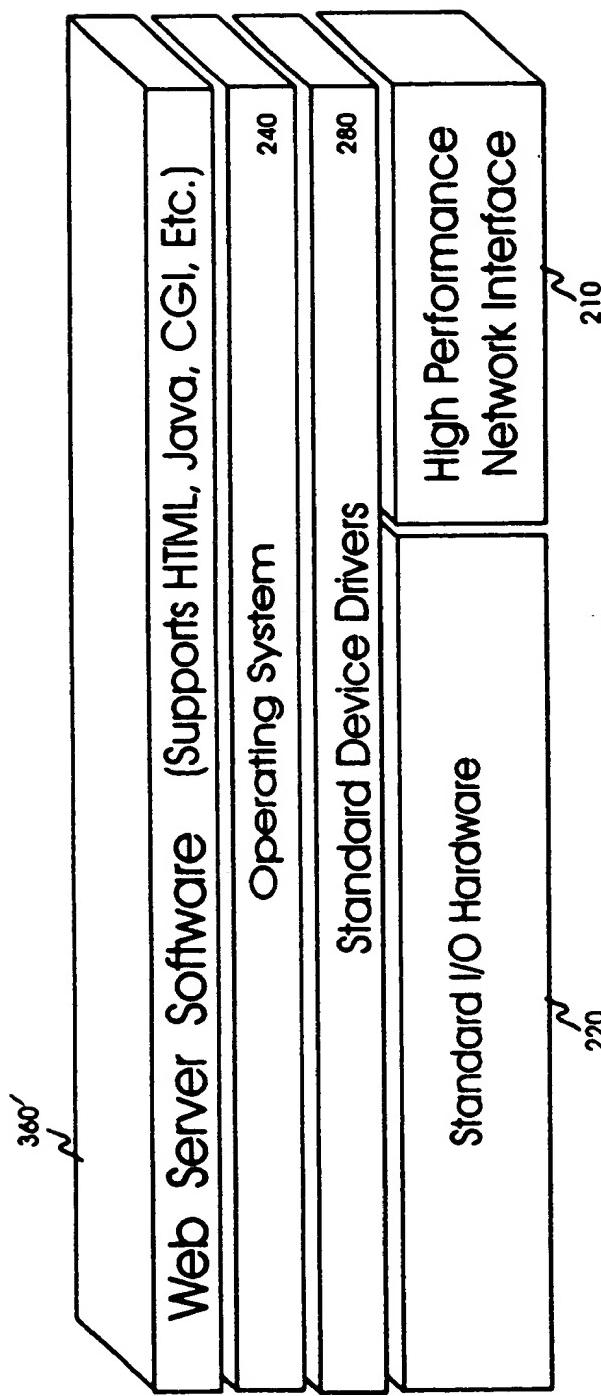
F I G. 16C

WEB-BASED OBJECT TRAJECTORY MONITORING SERVER 1002

360″

| Web Server Software (Supports HTML, Java, CGI, Etc.) |
| Operating System |
| 240 |
| Standard Device Drivers |
| 280 |

Standard I/O Hardware	High Performance Network Interface
220	210
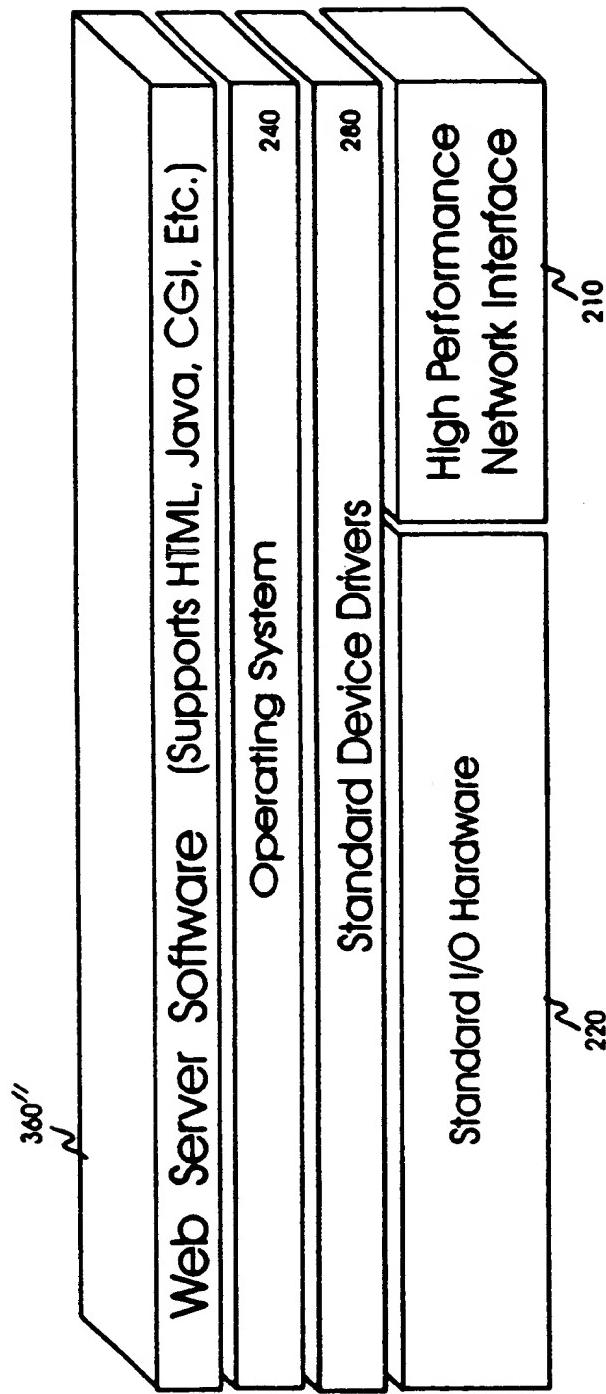
F I G. 16D

TIME-SPACE (T,S) COORDINATE TRACKING OF MOBILE OBJECTS

(T_2, S_2)

(T_3, S_3)

(T_1, S_1)

(T_i, S_i)
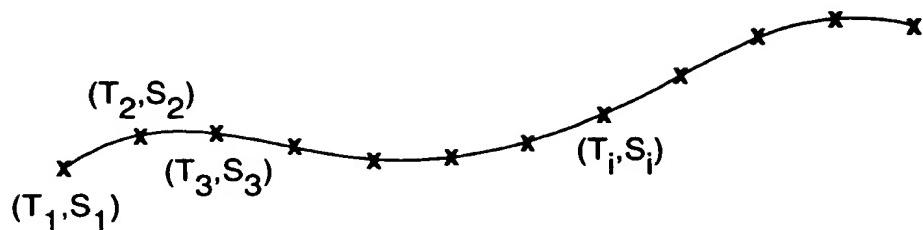
F I G. 17A

TIME-SPACE (T,S) STAMPING OF STATIONARY OBJECTS TO DETECT MOVEMENT THEREOF
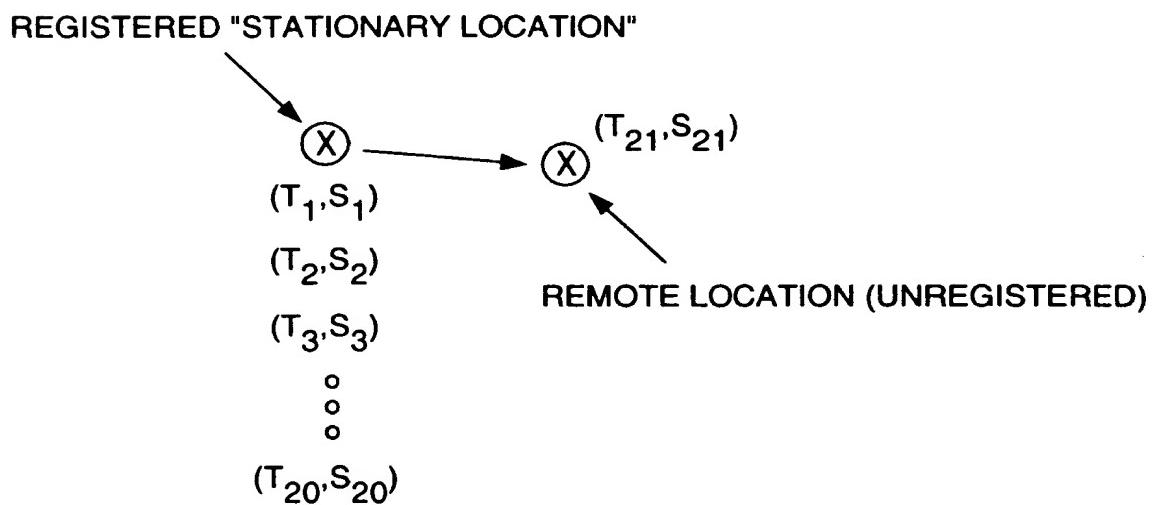
REGISTERED "STATIONARY LOCATION"

(X)

(T_1, S_1)

(T_2, S_2)

(T_3, S_3)

o
o
o

(T_{20}, S_{20})

(X) (T_{21}, S_{21})

REMOTE LOCATION (UNREGISTERED)

F I G. 17B

OWNER/OBJECT DATABASE TABLE

OBJECT NAME	OBJECT OWNER	GSU'S UNIQUE ID CODE (UIC)	TIME-SPACE STAMP		TIME-SPACE STAMP
TOM SMITH	TOM SMITH	1567N2B0	(T_1, S_1)		(T_i, S_i)
JERRY DOG	TOM SMITH	1568N2B0	(T_1, S_1)		(T_i, S_i)
VOLVO S80	TOM SMITH	1569N2B0	(T_1, S_1)		(T_i, S_i)
o o o	o o o	o o o	o o o	$\vdots$	o o o

F I G. 18

GSU-ENABLED CLIENT NETWORK DEVICE 160''

340'

TRACKING CLIENT

Operating System   240

TRACKING HOOKS AND DRIVERS   350'

| GSU | Clock and Timer Hardware | Output Hardware (Video Display, Speakers, Etc.) | Input Hardware | Network Interface (Modem, Ethernet, Etc.) |

175   290   310   305   300   215   307

Standard Device Drivers   280

BIO-PHYSIOLOGICAL DATA SENSOR (E.G. PULSE SENSOR)   309

ON-BOARD BATTERY-POWER LEVEL MONITORING MODULE AND SOLAR POWER CELL MODULE

PACKAGE-REMOVAL/ TAMPER-EVIDENCE SENSOR

F I G. 19A

FRACTAL ANTENNA STRUCTURE

GSU (175)

BIO-PHYSIOLOGICAL SIGNAL SENSOR

F I G. 19B

TIME-SPACE BIOPHYSIOLOGICAL (TSB)
STAMPING BASED TRACKING SERVER 1007

270'

TSB-TRACKING SERVER DAEMON

Operating System — 240

Standard and Customized Device Drivers — 230

| GPS RECEIVER | High Precision Clock or Timer Hardware | Standard I/O Hardware | High Perfomance Network Interface |

170

200

220

210

FIG. 20

(T,S,B) COORDINATE TRACKING OF MOBILE OBJECTS

(T_2,S_2,B_2)

(T_1,S_1,B_1) (T_3,S_3,B_3) (T_i,S_i,B_i)
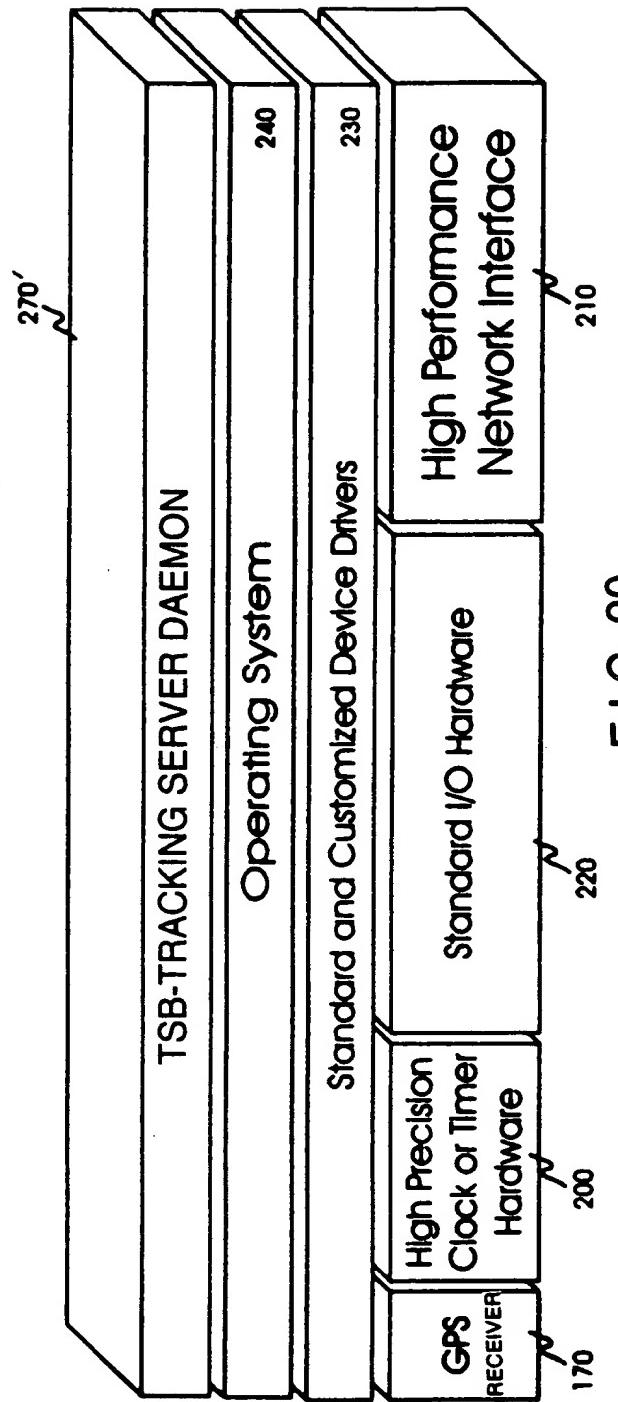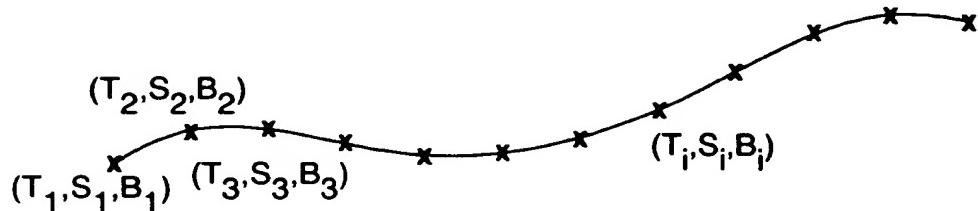
F I G. 21

OWNER/OBJECT DATABASE TABLE

OBJECT NAME	OBJECT OWNER	GSU'S UNIQUE ID CODE (UIC)	TSB STAMP		TSB STAMP
TOM SMITH	TOM SMITH	1567N2B0	(T_1,S_1,B_1)		(T_i,S_i,B_i)
JERRY DOG	TOM SMITH	1568N2B0	(T_1,S_1,B_1)		(T_i,S_i,B_i)
VOLVO S80	TOM SMITH	1569N2B0	(T_1,S_1,B_1)		(T_i,S_i,B_i)
○ ○ ○	○ ○ ○	○ ○ ○	○ ○ ○	○○○	○ ○ ○

F I G. 22
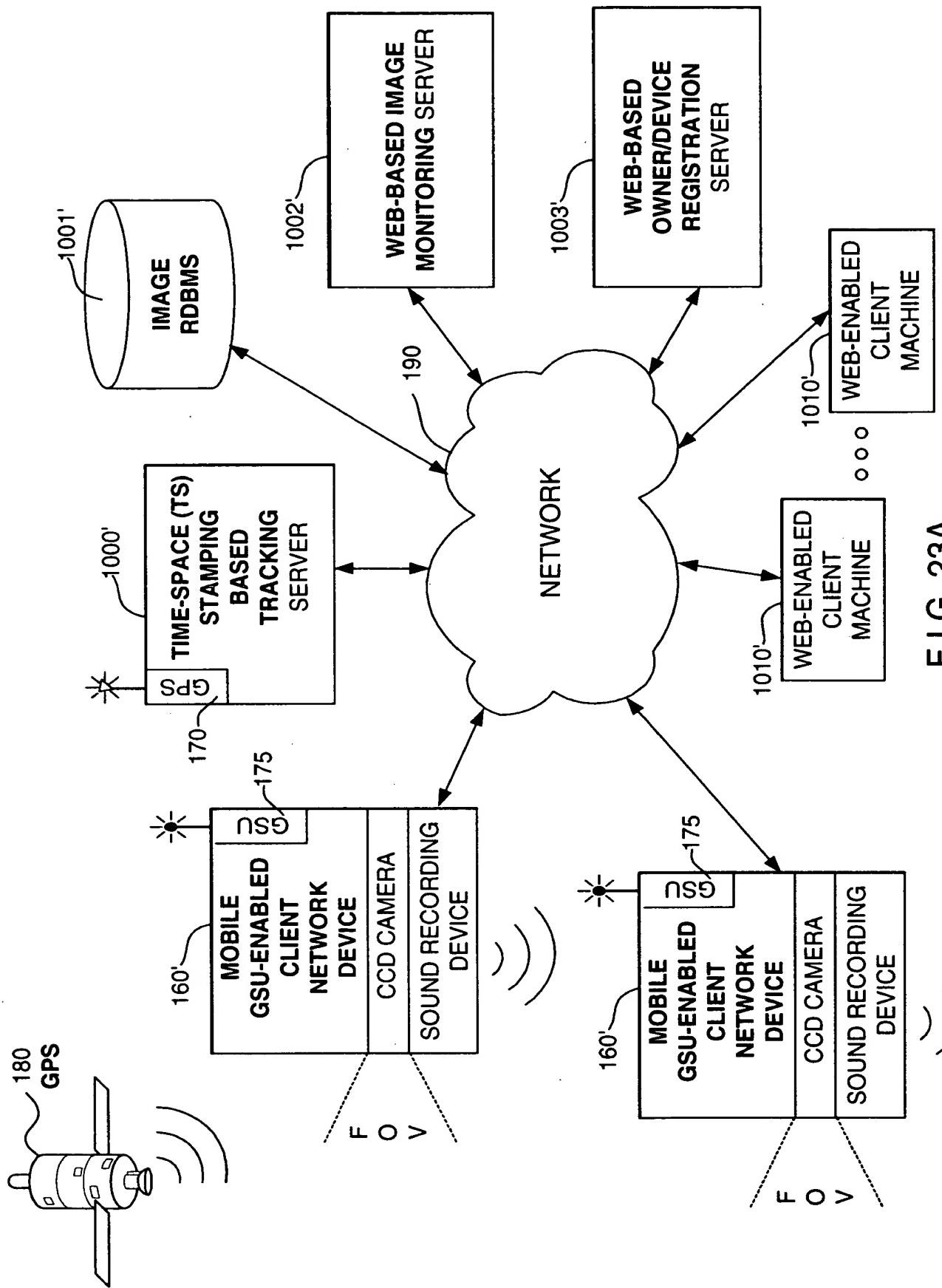
F I G. 23A

GSU-ENABLED CLIENT NETWORK DEVICE	TS-STAMPED CAPTURED IMAGE			
	T1	T2	o o o	TN
X125132			o o o	
X123561			o o o	
o o o				
X351275			o o o	

F I G. 23B

GPS
180

MOBILE GSU-ENABLED CLIENT NETWORK DEVICE
160'

GSU
175

MOBILE GSU-ENABLED CLIENT NETWORK DEVICE
160'

GSU
175

TIME-SPACE (TS) STAMPING BASED TRACKING SERVER
1000'

GPS
170

OBJECT/DEVICE RDBMS
1001'

WEB-BASED NETWORK ACCESS MONITORING SERVER
1002'

COMMUNICATION SUBNETWORK

WEB-BASED OWNER/DEVICE REGISTRATION SERVER
1003'

NETWORK

190

WEB-ENABLED CLIENT MACHINE
1010

WEB-ENABLED CLIENT MACHINE
1010

o o o

F I G. 24A

TS-REGION ENABLING ACCESS
TO COMMUNICATION
SUBNETWORK OR WWW SERVER

(T_2, S_2)

(T_3, S_3)

(T_1, S_1)

(T_i, S_i)
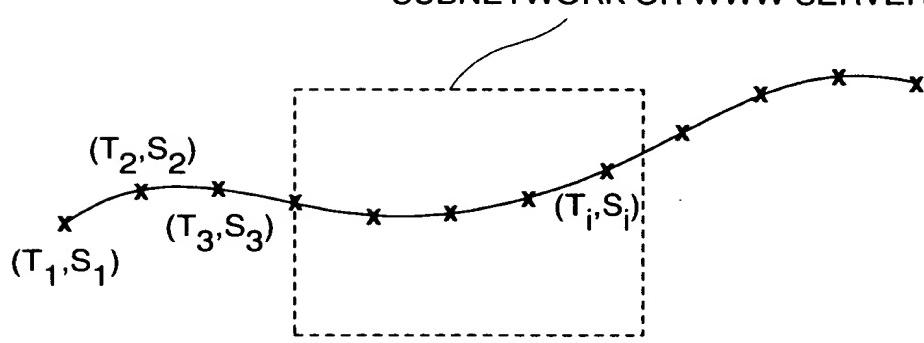
F I G. 24B
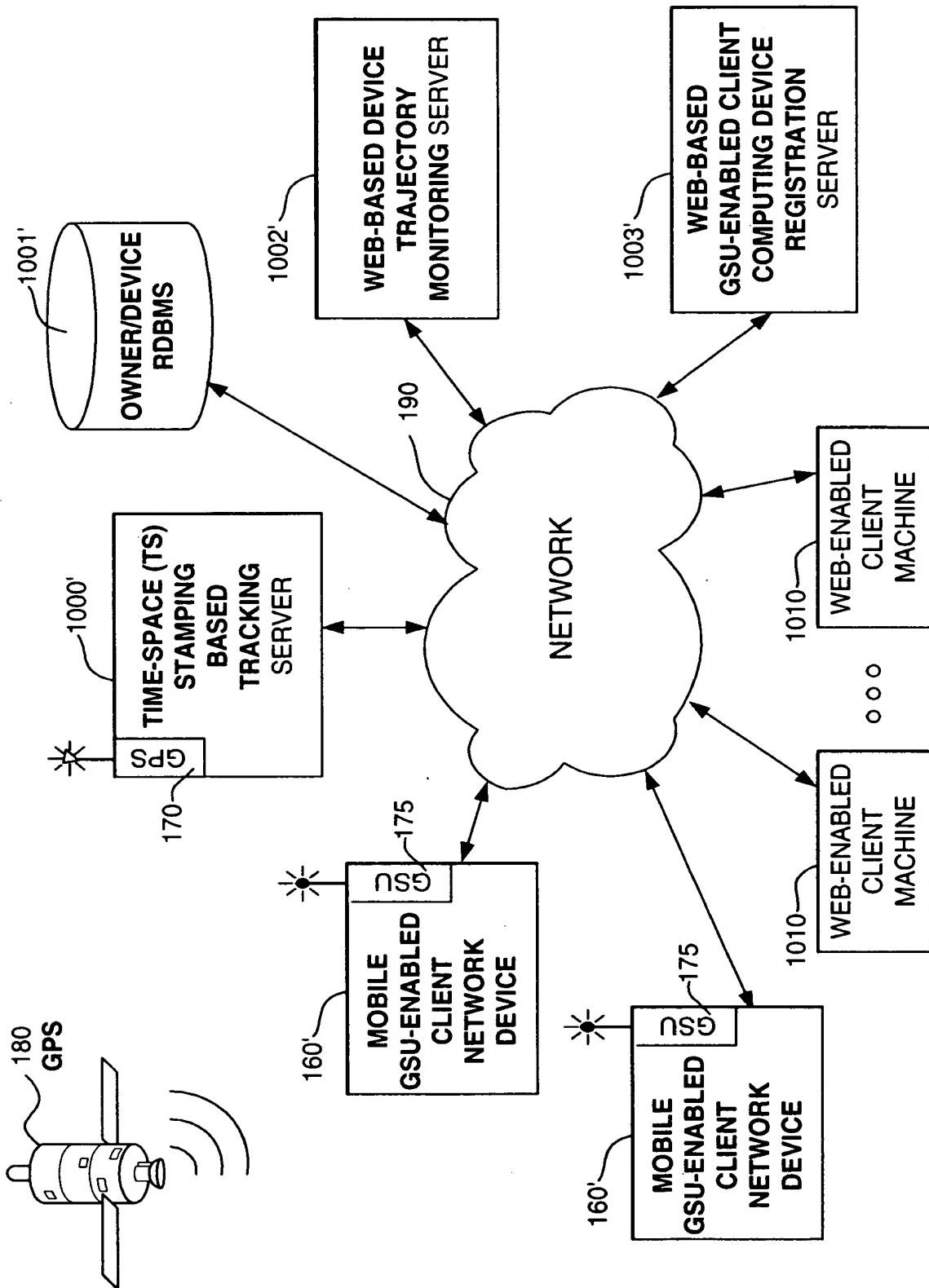
FIG. 25A

TS-REGION ENABLING DECRYPTION AND
DISPLAY OF ENCRYPTED MESSAGES, ON GSU-
ENABLED CLIENT COMPUTING DEVICE

(T_2, S_2)

(T_3, S_3)

(T_1, S_1)

(T_i, S_i)
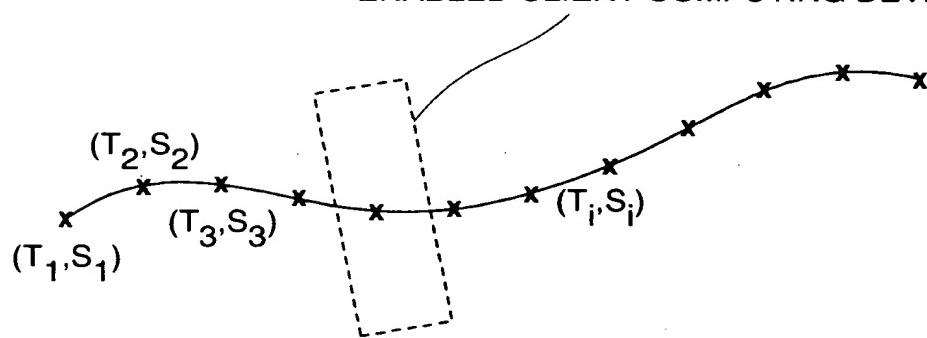
F I G. 25B
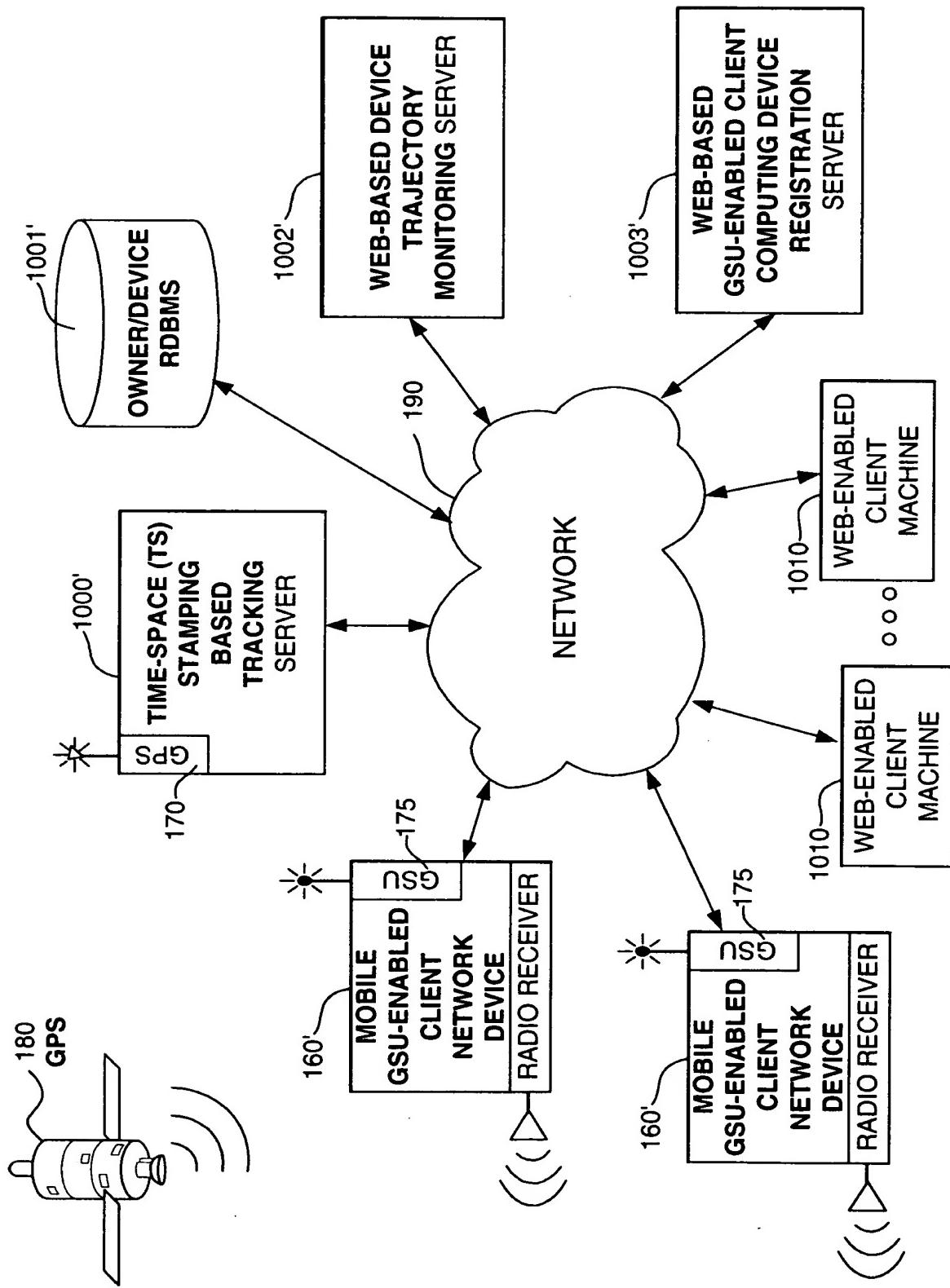
F I G. 26A

TS-REGION ENABLING DECRYPTION AND
DISPLAY OF ENCRYPTED RADIO MESSAGES

(T_2, S_2)

(T_3, S_3)

(T_1, S_1)

(T_i, S_i)

F I G. 26B

OWNER/DEVICE
RDBMS
1001'

WEB-BASED DISPLAY
MONITORING SERVER
1002'

WEB-BASED
GSU-ENABLED CLIENT
COMPUTING DEVICE
REGISTRATION
SERVER
1003'

190

NETWORK

WEB-ENABLED
CLIENT MACHINE
1010'

TIME-SPACE (TS)
STAMPING
BASED
TRACKING
SERVER
1000'

GPS
170

o o o

175
GSU

MOBILE
GSU-ENABLED
CLIENT
NETWORK
DEVICE
160'

WEB-ENABLED
CLIENT MACHINE
1010'

175
GSU

MOBILE
GSU-ENABLED
CLIENT NETWORK
DEVICE
160'

180
GPS

F I G. 27A

TS-REGION ENABLING DECRYPTION AND
DISPLAY OF ENCRYPTED MESSAGE(S)

(T_2,S_2)

(T_3,S_3)

(T_1,S_1)

(T_i,S_i)

F I G. 27B

FIG. 28A

TS-REGION ENABLING OPERATION OF
GSU-ENABLED MEDIA CONTENT DELIVERY DEVICE

(T_2, S_2)

(T_3, S_3)

(T_1, S_1)

(T_i, S_i)

F I G. 28B

GPS 180

OWNER/DEVICE RDBMS 1001'

WEB-BASED DEVICE TRAJECTORY MONITORING SERVER 1002'

WEB-BASED OWNER/DEVICE REGISTRATION SERVER 1003'

TIME-SPACE (TS) STAMPING BASED TRACKING SERVER 1000'

GPS 170

190

NETWORK

175

GSU

MOBILE GSU-ENABLED CLIENT NETWORK DEVICE 160'

MEDIA CONTENT DELIVERY DEVICE

175

GSU

MOBILE GSU-ENABLED CLIENT NETWORK DEVICE 160'

MEDIA CONTENT DELIVERY DEVICE

WEB-ENABLED CLIENT MACHINE 1010

o o o

WEB-ENABLED CLIENT MACHINE 1010

F I G. 29A

TS-REGION ENABLING OPERATION OF OR
CONTROLLING A FUNCTION(S) WITHIN A (PORTABLE)
HOST SYSTEM OR DEVICE OF PRESENT INVENTION

(T_2, S_2)

(T_3, S_3)

(T_1, S_1)

(T_i, S_i)

F I G. 29B